MATERIAL QUALITY OF STAINLESS STEELS IN S³P TREATMENT

INFLUENCE OF ALLOYING ELEMENTS AND DISTRIBUTION
HOMOGENEOUS MICROSTRUCTURE
INCLUSIONS ARE WEAK SPOTS
S³P increases surface hardness and wear resistance of austenitic, martensitic and duplex stainless steels. For low-temperature diffusion processes to be most successful, it is necessary to use quality materials that allow a uniformly hardened zone to be achieved. A number of factors relating to the quality of the material being treated can influence S³P treatment results.

Elements and distribution

The chemical composition of stainless steel alloys should include more than 12 wt% chromium to achieve a chemical inertness, and evenly distributed chromium within the microstructure ensures the formation of a uniform protective passive layer. In contrast, sulfur improves machinability, but considerably lowers the corrosion resistance (fig. 1 a-b). Finely dispersed sulfur below 0.005 wt% is recommended for achieving the best S³P results.

Material microstructure

Besides individual alloying elements, the microstructure of the alloy should be formed homogeneously, optimally without structural defects. When there is a noble surface region with high corrosion resistance next to an area with poor corrosion resistance, a “galvanic element” is created (fig. 2). This can cause galvanic corrosion and the region with poor corrosion resistance is sacrificially dissolved.

Microstructural weak spots:

- Inclusions, segregations and precipitations can be considered as impurities which weaken the passive film (fig. 3). The larger and more numerous these are, the lower the corrosion resistance will be.
- All types of inclusions with a different chemical composition than the base microstructure can form a galvanic element. Reduction in corrosion resistance can be caused by delta ferrite in an austenitic structure, but most critical are sulfide or carbide stringers.
- Deformation martensite can be formed during machining, leading to a changed material microstructure. The formation of precipitations in the near-surface material can lead to reduced corrosion resistance.

In many cases, it is recommended to apply homogenising or solution annealing, chemical pickling or electropolishing, to reduce microstructural defects before applying S³P processes to achieve the best results.